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(54) [Title of the Invention] PORTABLE TELEPHONE USING EMI SHIELD AND MANUFACTURING MEHTOD THEREOF

(57) [Abstract]

[Object] It is an object to provide a portable telephone with an EMI shield having an excellent shielding effect, and a manufacturing method of the portable telephone.

[Structure] a portable telephone and a manufacturing method thereof, which uses an EMI shield at joints of a telephone set outer enclosure, wherein the EMI shield is formed of conductive liquid silicon rubber having a self adhesive property.

[Effect] A packing conforming to the shape of the joints of the cover member in advance need not be

molded with a mold, or a packing need not be punched from a sheet. Furthermore, the adhesion step of packing can be omitted. Accordingly, manufacturing cost is lowered.

[What Is Claimed Is:]

[Claim 1] A portable telephone using an EMI shield at joints of a telephone set outer enclosure, wherein said EMI shield is formed of conductive liquid silicon rubber having a self adhesive property.

[Claim 2] A manufacturing method for a portable telephone using an EMI shield at joints of a telephone set outer enclosure, comprising the steps of:

forming conductive liquid silicon rubber packing in a place of the telephone set outer enclosure by using a FIPG method and thereby obtaining a cover packing assembly, said liquid silicon rubber having a self adhesive property; and

assembling the cover packing assembly and an enclosure enclosing a telephone body, as a single unit.

[Detailed Description of the Invention]

[0001] The present invention relates to a portable telephone using an EMI shield and, more particularly, to a portable telephone using an EMI shield which is easily manufactured and has an excellent shield effect.

[0002]

[Prior Art] In recent years, along with widespread use of mobile telephones, portable telephones, and the like, electromagnetic waves generated by these equipments adversely affect human bodies, thereby posing a social problem. The electromagnetic waves generated by a portable telephone adversely affect the nearby electronic equipments, and electromagnetic waves generated by the nearby electronic equipments in turn cause operation errors of the portable telephone. An electromagnetic interference (EMI) shield is provided in a recent portable telephone so as to cope with such radio interference.

[0003] A currently used general EMI shield is arranged as follows. A telephone body is accommodated in a conductive enclosure and grounded. In addition, an outer enclosure cover is attached through a conductive packing in order to prevent entrance and leakage of electromagnetic waves from a packing portion, thereby obtaining a single unit. In this case, as the conductive packing, a packing punched from a sheet molded upon mixing a metal wire mesh or a metal powder in a rubber material, or an injection-molded band-like packing is used.

[0004] To attach the above conductive packing, however, an adhesion process is required for the punched packing.

The band-like packing must be filled in a guide groove formed in the outer enclosure cover, resulting in a cumbersome, time-consuming operation.

[0005]

[Problems That the Invention Is to Solve] The present inventors have made extensive studies to eliminate the above drawback and found that if the joints of the outer enclosure for accommodating a portable telephone body are covered with conductive liquid silicone rubber having a self adhesive property by an FIPG method, an EMI shield can be easily and precisely provided, and an inexpensive portable telephone having an excellent shielding effect can be easily manufactured. The present inventors thus attained the present invention. It is, therefore, an object of the present invention to provide a portable telephone which is easily manufactured and has an EMI shield having an excellent shielding effect.

[0006] The above object is achieved by a portable telephone and a manufacturing method thereof, which uses an EMI shield at joints of a telephone set outer enclosure, wherein the EMI shield is formed of conductive liquid silicon rubber having a self adhesive property.

[0007] The liquid silicone rubber used in the present invention can be properly selected from known addition

or condensation curing silicone rubber materials. In particular, an addition curing silicon rubber material is preferable in favor of good finish, fast curing, and good adhesion strength.

[0008] According to the present invention, when addition curing liquid silicon rubber is used, it is preferable to use rubber having a combination of diorganosiloxane having an aliphatic unsaturated group such as a vinyl group and organohydrogenpolysiloxane having a hydrogen atom bonded to a silicon atom. In this case, straight-chain diorganosiloxane having at least two lower alkenyl groups, directly bonded to the silicon atom, in each molecule is preferable as the organopolysiloxane having an aliphatic unsaturated group.

[0009] A crosslinking agent used in the present invention is subjected to an addition reaction with the aliphatic unsaturated group in the diorganopolysiloxane to crosslink diorganopolysiloxanes. Organohydrogenpolysiloxane containing a hydrogen atom bonded to a silicon atom is generally used as the crosslinking agent. In this case, the organohydrogenpolysiloxane may have a straight-chain, cyclic, or branched molecular structure, but must have at least two hydrogen atoms directly bonded to the silicon atom in each molecule. This crosslinking agent

is subjected to the addition reaction with the diorganopolysiloxane to extend the chain length of the molecules in the diorganopolysiloxane, thereby lowering the hardness of the cured product or increasing its strength. A combination of this crosslinking agent and organohydrogenpolysiloxane having at least three hydrogen atoms can control the hardness and modulus of elasticity of the cured product upon crosslinking.

[0010] When the combination of the diorganopolysiloxane having an aliphatic unsaturated group and the organohydrogenpolysiloxane having hydrogen atoms bonded to the silicon atom is used as the base material of the conductive liquid silicone rubber, the mixing ratio of the diorganopolysiloxane and the organohydrogenpolysiloxane preferably falls within the range of 0.5 to 4 and particularly 1 to 2 in the molar ratio of the Si-H group in the organohydrogenpolysiloxane and the aliphatic unsaturated group in the diorganopolysiloxane.

[0011] The conductive liquid silicone rubber is obtained by adding a platinum-based curing catalyst, an adhesion imparting agent, a conductivity imparting agent, a reinforcing filler such as reinforcing silica, and other additives in the liquid silicone rubber in appropriate amounts.

[0012] The adhesion imparting agent added to the

liquid silicone rubber of the present invention can be appropriately selected from known materials. A silicon compound having an adhesion imparting functional group such as an epoxy group or an alkoxy group in each molecule can be used. Alternatively, a silicon compound also containing a vinyl group or a hydrogen atom directly bonded to a silicon atom required for the addition reaction in each molecule may be used.

[0013] Examples of the conductivity imparting agent are a π-electron mobility type conductive material (e.g., a carbon black powder, a graphite powder, or a carbon fiber), a metal (e.g., silver, nickel, copper, zinc, iron, or silicon), and an oxide, carbide, or alloy of such a metal. The shape of the conductivity imparting agent is the form of a powder, flake, or fiber. A free electron mobility type conductive material obtained by coating the surface of a nonconductive inorganic material (e.g., glass, mica, and alumina) powder, flake, or fiber with a metal such as silver can also be used.

[0014] The above materials are preferably mixed such that the viscosity of the conductive liquid silicone rubber used in the present invention, which is measured by a rotaviscometer falls within the range of 1,000 to 1,000,000 poise at 25°C in view of workability and the form-holding properties. In addition, the hardness

after heat curing preferably falls within the range of 10 to 80 Hs (measurement complying with JIS K6301 A) to reduce the stress acting on the cover member.

[0015] The conductive liquid silicone rubber having the self adhesive property thus obtained can be fed with a pump. For example, the silicone rubber can be applied on a hard disk with nozzle discharge. In this case, the finished cross-sectional shape is generally semispherical. However, the discharge conditions such as the nozzle height can be appropriately adjusted to obtain a semispherical shape with a flat top.

[0016] According to the present invention, the joints of the portable telephone cover are covered with the conductive liquid silicone rubber having a self adhesive property by the FIPG method to obtain a cover packing assembly.

[0017] The FIPG (Formed In PlaceGasket) method employed in the present invention is a method of forming a free molded gasket or in-place molded gasket. A coating robot, a feed pump, and a dispenser are combined. The liquid silicone rubber is supplied with the feed pump and dispensed by the dispenser. At the same time, the silicone rubber is applied with the coating robot in accordance with a prestored pattern to form a gasket. Therefore, by coating the silicone rubber using the robot mechanism in accordance with the

prestored pattern, the conductive liquid silicone rubber can be accurately applied to the joints of the cover member of the portable telephone.

[0018] A cover packing assembly having the packing thus obtained is fastened with screws to the enclosure attached to the telephone body to manufacture a portable telephone. In this case, since the hardness of the packing falls within the range of 10 to 80 Hs as described above, the stress that acts on the cover can be effectively reduced. According to the present invention, after the conductive liquid silicon rubber is applied, the cover may be subjected to a cleaning process such as washing with water, cleaning with air, and drying, as needed.

[0019]

[Effect of the Invention] According to the present invention, a packing conforming to the shape of the joints of the cover member in advance need not be molded with a mold, or a packing need not be punched from a sheet, thereby obviating the need for a mold or die. Since the silicone rubber is directly formed on or adhered to the cover, the adhesion step of adhering the cover with the molded or punched product, which is required for the molded or punched product, can be omitted. As the cover is directly coated with the silicone rubber, no burrs are formed, and material loss

in punched products can be eliminated. The conductive silicone rubber packing is excellent in the EMI shielding properties, and operation errors of the portable telephone due to external electromagnetic waves, and leakage of interfering electromagnetic waves generated upon receiving an incoming call can be prevented. Furthermore, the silicone rubber packing is excellent in weather resistance. The present invention is suitable for a portable telephone used outdoors.

[0020]

[Examples] The present invention will be described in detail by way of its examples. The present invention, however, is not limited to these examples.

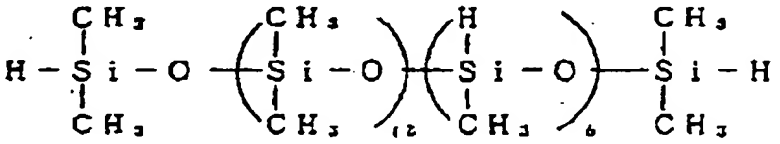
[0021] Example 1

An aluminum cover was coated with a conductive liquid silicone rubber material having composition example 1 in Table 1 using a coating robot (available from YASUKAWA Electric Corp.) in accordance with a prestored pattern.

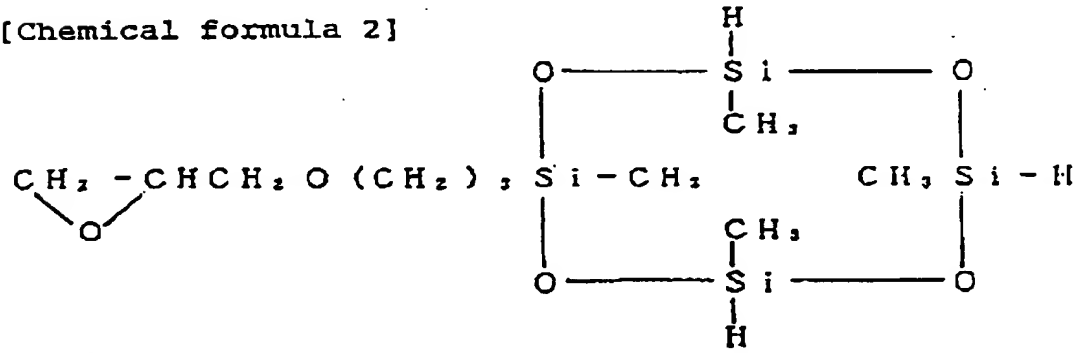
[Table 1] Composition Example 1: Silicon oil (polydimethylsiloxane having vinyl at both terminals, viscosity: 1,000 cp): 100 parts by weight, organohydrogenpolysiloxane (chemical formula 1): 2.5 parts by weight, platinum-based catalyst (chloroplatinic acid): 0.2 parts by weight, silica filler treated with silazane: 10 parts by weight,

ethynyl cyclohexanol to regulate the reaction: 0.5 parts by weight, conductive carbon powder (Bellpearl C-2000S available from KANEBO LTD.): 190 parts by wight, and adhesion imparting agent (chemical formula 2): 1.0 parts by weight.

[Chemical formula 1]



[Chemical formula 2]



[0022] The coating conditions were a nozzle inner diameter 3.0 mm, a supply pump pressure of 1.8 kgf/m^2, a coating speed of 230 mm/min, and a nozzle height (from the cover surface) of 3.5 mm. After coating, the silicone rubber composition was placed and cured in a hot-air dryer at 150°C. The cured silicone rubber composition was then cooled to obtain a packing having a semispherical cross-section with a height of 2.5 mm and a width of 3.5 mm and a volume resistivity of 2.0 Ω·cm. This packing perfectly and properly adhered to

the surface of the cover material. The resultant packing was cleaned with pure water which was filtered through a 0.5-μm filter and whose conductivity was adjusted to 10 μs or less, thereby obtaining a cover-packing assembly for the portable telephone.

[0023] To evaluate the electromagnetic shielding effect of the resultant packing, the packing material was formed into a flat sample (sample dimensions: inner diameter of 1.5 mm, an outer diameter of 50.0 mm, and a thickness of 5.0 mm). The sample was placed in a transfer impedance measurement jig ZTR39D (available from MITSUBISHI CABLE INDUSTRIES, LTD.), and the frequency characteristics of the transfer impedance were measured using a network analyzer (available from YOKOGAWA Hewlette Packerd K.K.), thereby obtaining data shown in Fig. 1. The result obtained indicated that the packing material had an excellent EMI shielding effect in the frequency range of 0.3 MHz to 1 GHz.

[0024] Example 2

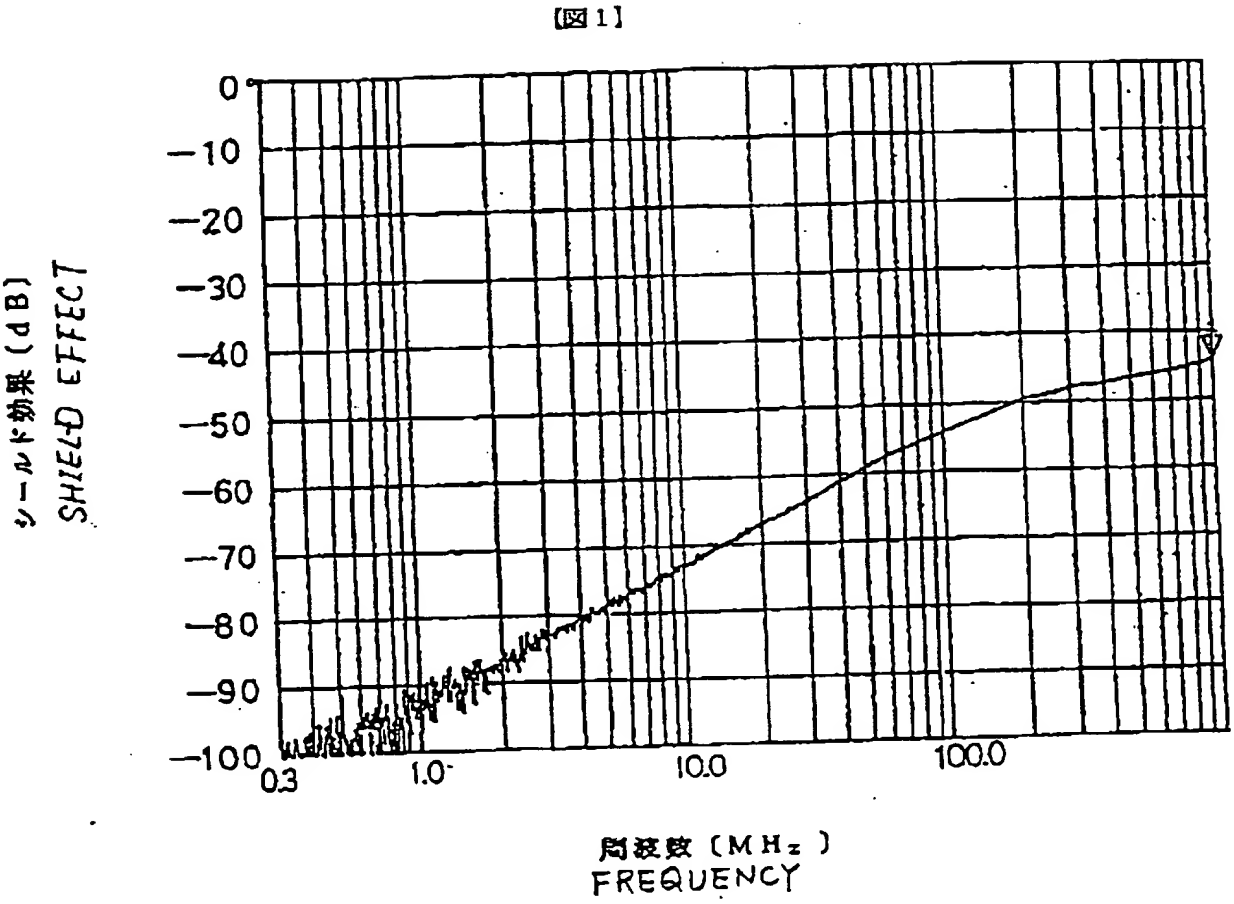
An aluminum cover was coated with a packing following the same procedures as in Example 1 except that 170 parts by weight of a conductive Ni-coated phenol resin powder (Bellpearl C-800 available from KANEBO LTD.) were used in place of 190 parts by weight of the conductivity imparting agent in composition 1 used in Example 1, and the temperature of the hot-air

dryer was set to 140°C. The resultant packing had a semispherical cross-section with a height of 2.5 mm and a width of 3.5 mm and a volume resistivity of 1.0 Ω·cm. The packing sufficiently and properly adhered to the surface of the cover material. The resultant packing was cleaned with pure water which was filtered through a 0.5-μm filter and whose conductivity was adjusted to 10 μs or less, thereby obtaining a cover-packing assembly for the portable telephone. The electromagnetic shielding effect of the resultant packing was evaluated following the same procedures as in Example 1. The same evaluation as in Example 1 was obtained.

[Brief Description of the Drawing]

Fig. 1 shows the frequency characteristics of the transfer impedance obtained for the packing prepared in Example 1.

[Fig. 1]


[図1]
シールド効果 (dB)
SHIELD EFFECT
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
0.3
1.0
10.0
100.0
周波数 (MHz)
FREQUENCY

D1

EINGEGANGEN 6. Sep. 1997

DECLARATION

I, Toshio Sato, residing at Suite 510, Kioicho TBR Bldg. 7, Kojimachi 5-chome, Chiyoda-ku, Tokyo, Japan, do hereby solemnly and sincerely declare that I well understand the English and Japanese languages and that the attached English translation is correct and faithful translation of the Japanese Patent Provisional Publication No. 5-7177.

Signed this 8th day of August, 1997

Toshio Sato

Toshio Sato